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UNITED STATES PATENT APPLICATION

of

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for

SWITCH MACHINE WITH IMPROVED SWITCH POINT CONNECTORS

TITLE OF THE INVENTION

Switch Machine with Improved Switch Point Connectors

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

Field of the Invention - The present invention is in the field of railroad switching devices, namely the equipment which is used to displace railroad switch points. More specifically, the invention refers to a pivoting connector which connects each of the operating rods of the switching device to the associated switch point, in a non-binding relationship.

Background Art - A railroad switch point consists of tapered rail sections which are capable of being selectively displaced between two different lateral positions at a rail switch and then locked in the selected position, in order to facilitate the desired routing of a train passing through the switch. The two switch points are typically displaced by rods extending from an assembly which is referred to herein as a "switch machine". Inside the switch machine the rods are usually connected to a motive mechanism which provides reciprocating rectilinear motion, controlled by a power unit which is usually placed to one side of the rails.

Such a device is described in Italian Patent No. IT1246656, to the inventor herein. The device described in that patent operates switch points which are independent, or disconnected, from each other, and it is not applicable to the problem of operating switch points of the interconnected type, i.e. of switch points connected to each other by transverse bars. Switch machines of the interconnected type are shown, for example, in U. S. Patent Nos. 5,806,809 and 6,149,106.

The switch machine combines the switch point movement and switch point locking functions into a single mechanism to reduce mechanical complexity,

enclosing the mechanism in a weather-proof housing, incorporating sensors and other electrical control components in the housing and locating the housing and operating assembly beneath the switch points and the associated rails.

In such switch machines, binding may occur, as described below, when the operating rod does not move along its intended longitudinal line of action, but rather is subjected to lateral forces tending to cause it to bind at its attachment to the switch point and where the operating rod passes through the switch machine housing. A bearing and a seal are usually provided at the entry point into the housing, to align the operating rod and to seal out water and other contaminants. The outer end of each operating rod connects to an associated switch point, and as the operating rod is moved into and out of the switch machine housing, this substantially longitudinal movement of the operating rod is used to apply force to move the associated switch point laterally. The lateral movement of the switch point requires some change in the angle between the operating rod and the switch point, because the switch point is actually pivoting about a pivot point at the other end of the switch point rail section. So, this change in angle can apply a lateral reactive force on the outer end of the operating rod, causing the inner end of the operating rod to apply substantial lateral force to the bearing and seal mechanism through which the operating rod enters the switch machine housing. This lateral reactive force can cause premature failure of the seal and binding of the operating rod relative to the housing, which can cause the switch machine to lock up.

It would be desirable to have a means for preventing this application of lateral force to the outer end of the operating rod, in order to eliminate the binding of the operating rod at the housing, and in order to preserve the condition of the housing seal.

BRIEF SUMMARY OF THE INVENTION

The present invention is illustrated as implemented with a switch machine for operating a switch having switch points. Two operating rods extend from either side of a fixed housing positioned between intersecting rails, to the movable switch points, with the rods being capable of longitudinally sliding relative to the housing. Movement of the operating rods moves the switch points between two positions

between the pair of rails. The switch machine operates to hold the rods in place to selectively lock the operating rods and the switch points in a desired position.

In accordance with the present invention, a pivoting connector assembly is provided on the outer end of each operating rod. In one form of the invention, a socket mounted or formed on the outer end of the operating rod has a vertically oriented bore into which a pivot shaft is positioned, with a collar at the top of the vertical pivot shaft. A horizontal bore is formed in the collar, and the collar bore is adapted to pivot about the vertical axis of the pivot shaft. A horizontal pivot pin is attached essentially parallel to each switch point. This pivot pin is positioned through the collar bore, in a sliding arrangement. As the operating rod moves the switch point laterally, the collar slides along the horizontal pivot pin by a slight amount. Further, as the switch point moves laterally, the collar pivots about the vertical axis to maintain the alignment of the collar bore axis with the horizontal axis of the pivot pin. This prevents the pivot pin from imposing a lateral reactive force on the operating rod.

The novel features of this invention, as well as the invention itself, will be best understood from the attached drawings, taken along with the following description, in which similar reference characters refer to similar parts, and in which:

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 is an exploded view of the lower components of a switch machine which can implement the present invention;

Figure 2 shows the switch mechanism holding the switch points in the full right position in the locked mode;

Figure 3 shows the switch machine in the full right position of Figure 2, but with the control rod moved to the left to unlock the switch machine to move the switch points;

Figure 4 shows the switch machine with the control rod moved further to the left to move the switch points from the full right position toward the full left position;

Figure 5 shows the switch points moved to the full left position;

Figure 6 shows a switch machine incorporating a modification according to

the present invention;

Figure 7A shows a schematic view of the rail layout of a switch point;

Figure 7B shows a top plan view of the apparatus in Figure 6;

Figure 8 shows a perspective view of a pivoting connector according to the present invention;

Figure 9 shows a first form of the connector according to the present invention;

Figure 10 shows another form of the connector according to the present invention; and

Figures 11 and 12 show sectional views of a collar on the connector along line 11-11 of Figure 10.

DETAILED DESCRIPTION OF THE INVENTION

As seen in the attached drawings, the switch machine includes three basic types of fixed components: a fixed housing 1; a plate 2 fixedly mounted within or otherwise attached to the housing 1; and two guides 3 fixedly mounted within or otherwise attached to the housing 1, below the level of the fixed upper plate 2. A capture mechanism, including a plurality of capture elements and a shifting body, is used to selectively engage and disengage two operating rods 4, 5 to and from the fixed upper plate 2. More specifically, an upper set of interlocking or capture elements are provided to selectively interlock or engage the two operating rods 4, 5 with either the fixed upper plate 2 or the shifting body within the housing 1. As part of the upper set of interlocking elements, the fixed upper plate 2 is provided with two ball seats 24 mounted on the upper side thereof. Each of the ball seats 24 houses a corresponding disk or follower plate 21 which can be completely inserted in its respective ball seat 24 against the action of a spring 22. A lower set of interlocking elements are also provided to selectively interlock the shifting body with either the two fixed lower guides 3 or a control rod 8. As part of the lower set of interlocking elements, each of the two fixed lower guides 3 is provided with two transverse pin seats 32, with each pin seat 32 having sloping walls.

The movable components include the two operating rods 4, 5 which slidingly contact the lower side of the fixed plate 2, and which move the two switch points A1,

A2 transversely. The switch points A1, A2 are connected by one or more transverse bars 9, so that the switch points A1, A2 always move together and maintain their transverse spacing. The switch points A1, A2 can move so that they contact either of two stock rails C1, C2 for the purpose of directing a passing rail car along the desired track. Each operating rod 4, 5 is provided with a through hole 41, 51 sized to allow a ball 42 to pass therethrough, with each ball 42 being sized to pass into one of the ball seats 24. The thickness of each operating rod 4, 5 in the vicinity of its respective through hole 41, 51 is at least half the diameter of the ball 42. One skilled in the art will recognize that a pin of suitable configuration could be used instead of the ball 42, and it could pass through corresponding shaped slots instead of the through holes 41, 51.

The shifting body within the housing 1 includes a skate 6 and an intermediate shift assembly 7. The skate 6, which slidingly contacts the lower sides of the operating rods 4, 5 is provided with two ball slots 61, 62 recessed into its upper surface, oriented transverse to the longitudinal axis of the skate 6. The wall of each ball slot 61, 62 closest to the center of the skate 6 slopes upwardly toward the center. Each ball slot 61, 62 is able to accept one of the balls 42, with the depth of the ball slot 61, 62 being no more than half the diameter of the ball 42. On the lower side of the skate 6 a semi-cylindrical lower central cavity 63 is provided, with the axis of the semi-cylindrical cavity 63 being parallel to the longitudinal axis of the skate 6. Two transversely oriented stabilizing recesses 65 are provided in the lower side of the skate 6, one stabilizing recess 65 being positioned beyond each end of the central cavity 63. Each stabilizing recess 65 is capable of housing one transversely oriented, cylindrical, end stroke stabilizing pin 66.

The intermediate shift assembly 7 is positioned in contact with the lower side of the skate 6, with the longitudinal axis of the shift assembly 7 parallel to the longitudinal axis of the skate 6. The shift assembly 7 includes a hollow central cylinder 71, provided with a cylindrical sleeve 72 fixedly surrounding each end of the central cylinder 71. Each sleeve 72 has two symmetrical wings 73 extending radially therefrom, transverse to the longitudinal axis of the shift assembly 7. The upper portion of the central cylinder 71 and the cylindrical sleeves 72 of the shift assembly 7 can be securely inserted into the central cavity 63 on the lower side of the skate 6.

The symmetrical wings 73 rest flat on the upper sides of the fixed guides 3, with the lower portions of the central cylinder 71 and the cylindrical sleeves 72 positioned between the fixed guides 3. Through slots 74 are provided in each of the wings 73, through which transversely oriented, cylindrical, shift pins 75 can pass in order to seat in the pin seats 32 in the upper sides of the fixed guides 3.

The control rod 8, controlled by an external power unit not shown in the drawings, enters the housing 1 from one side.. The control rod 8 can slide through the whole shift assembly 7, and it is provided with U-shaped right and left shift forks 81, 83 straddling the outer ends of the sleeves 72. The shift forks 81, 83 are fixedly mounted on, or integral with, the control rod 8, and they can partially slide over the tops of the wings 73 of the shift assembly 7. On the upper surface of each of the forks 81, 83 an approximately semi-cylindrical transverse groove 82 is provided, to receive the stabilizing pins 66 which are housed in the stabilizing recesses 65 in the lower side of the skate 6.

An external power unit (not shown) can be provided outside the rails, and mounted to one side of the housing 1, with a drive shaft, as is known in the art, passing under the rails and connected to the control rod 8 for achieving bi-directional longitudinal movement of the control rod 8.

In Figures 2 to 5, the sequential steps of the normal functioning of the switch machine are illustrated, and the relative positions of the switch machine components are shown. In Figure 2, the right switch point A2 is in contact with the right stock rail C2 at the full right end position of the stroke, and the control rod 8 is stabilized relative to the skate 6 by the left end stroke stabilizing pin 66 which is seated in the groove 82 on top of the left fork 83 and partially housed in the left stabilizing recess 65 in the lower side of the skate 6. In this position, the right operating rod 5 is captured relative to the fixed plate 2 by the right ball 42, which is partially housed by the right through hole 51 in the rod 5 and partially housed in the right ball seat 24 of the plate 2. Of course, because of the rigid connection between the switch points A1, A2 effected by the transverse bar 9, the left operating rod 4 is also held in place relative to the fixed plate 2. Therefore, in the configuration shown in Figure 2, the switch points A1, A2 are held in place at the right end of the stroke. Further, in this configuration, the shift assembly 7 is captured or latched relative to the fixed guides 3

by the left shift pins 75, which are partially housed in the through slots 74 in the left wings 73, partially housed in the left pin seats 32 of the fixed guides 3, and held in place by the left fork 83 extending over the through slots 74. This latching prevents any movement of the shift assembly 7, such as might be caused by vibration, in order to lock the switch machine in this position.

When it is desired to move the switch points A1, A2 from the right end position toward the left end position, movement of the control rod 8 toward the left part of the drawing, as indicated by the arrow in Figure 2, is caused by the aforementioned power unit. This movement of the control rod 8 first forces the left end stroke stabilizing pin 66 upwardly out of the left semi-cylindrical groove 82 into the left recess 65, allowing the control rod 8 to move leftward. In Figure 3, shortly after this movement toward the left is initiated, it can be seen that the inner edge of the right fork 81 is abutting the right shift pins 75 which in turn exert a force to the left on the left walls of the through slots 74 in the right wings 73 of the assembly 7. Further, the region over each left shift pin 75 is cleared by the displacement of the left fork 83 toward the left. It is at this point that the shift assembly 7 and the skate 6 are unlatched, and they can begin to move to the left relative to the fixed guide 3, in response to the force exerted by the right fork 81. Because of the extended length of the left ball slot 61, the control rod 8, the skate 6, and the shift assembly 7 can all move to the left relative to the left operating rod 4, even though the right ball 42 is still capturing the right operating rod 5 in place. As the shift assembly 7 moves to the left, the left shift pins 75 are pushed up the sloping left walls of the left pin seats 32 by the right walls of the through slots 74 in the left wings 73, until the shift assembly 7 is completely disengaged from the fixed guides 3.

As the control rod 8 continues to move to the left, the right fork 81 pushes the shift assembly 7 and the skate 6 to the left, with respect to the operating rods 4, 5, with the result that the right ball 42 is eventually expelled, by gravity and the spring 22, from the right ball seat 24 into the right ball slot 62 in the upper side of the skate 6. This releases the right operating rod 5 from the fixed plate 2; at the same time, the left ball 42 runs along the whole length of the left ball slot 61 on the skate 6. This sequence of movements, all initiated by the movement of the control rod 8 to the left, has the effect of unlocking the operating rods 4,5, the transverse bar 9, and the switch

points A1, A2 for movement to their respective left positions. Continued leftward movement of the control rod 8, the shift assembly 7, and the skate 6 pushes the left operating rod 4 to the left, because of the left ball 42 being abutted by the right wall of the left ball slot 61 and captured in the left ball slot 61 by the fixed plate 2. This configuration is shown in Figure 4. Leftward movement of the operating rods 4, 5 continues in this way, displacing the left switch point A1 and, in turn, the right switch point A2, which is connected to the left switch point A1 by the transverse bar 9. The switch points A1, A2 are thus moved away from the full right position and toward the left position.

As seen in Figure 5, leftward movement has continued until the left switch point A1 abuts the left stock rail C1, and the left ball 42 is positioned directly under the left disk 21 and the left ball seat 24. This positions the operating rods 4, 5 in their full left position.

At this left end point of the operating rods 4, 5, continued leftward movement of the control rod 8 causes the left ball 42 to be forced upwardly against the disk 21, because of the slope of the right wall of the left ball seat 61 and resistance to further movement of the ball 42 by the left side of the through hole 41. As the left ball 42 is forced upwardly, it compresses the spring 22, until the left ball 42 enters the left ball seat 24. Once the left ball 42 rises at least partially into the left through hole 41; it creates an interference which prevents the operating rods 4, 5 from moving farther relative to the fixed plate 2. However, the operating rod 8, the skate 6, and the shift assembly 7 can continue moving to the left because of the extended length of the right ball slot 62, until the right shift pins 75 engage the shift assembly 7 with the right pin seats 32 in the fixed guides 3.

The assembly made of the operating rods 4, 5, the transverse bar 9, and the switch points A1, A2, is also then captured relative to the fixed plate 2 by the left ball 42. At this point, the right shift pins 75 have aligned with, and dropped into, the right pin seats 32 in the fixed guides 3. Also, the right ball 42 has completed its displacement along the right ball slot 62, and it now abuts the right wall of the right ball slot 62. This abutment of the right ball 42 with the right wall of the right ball slot 62 has stopped the leftward movement of the skate 6 and the shift assembly 7 relative to the fixed plate 2. However, the control rod 8 and the forks 81, 83 have continued

to move leftward until the right shift pins 75 are captured within the right pin seats 32 of the fixed guides 3 by the right fork 81, securely latching or capturing the shift assembly 7 and the skate 6 relative to the fixed guides 3. Further, the right end stroke stabilizing pin 66 has dropped partially into the groove 82 on top of the fork 81, stabilizing the control rod 8 relative to the skate 6. This locks and latches the switch machine at the full left end of its stroke.

It can be seen that, in this locked and latched configuration, the control rod 8 is not affected by possible loads which may be exerted on the detached right switch point A2. Such loads are transmitted to the switch point A1 via the transverse bar 9, and to the operating rod 4, and they are then absorbed by the plate 2, to which the left operating rod 4 is captured. Furthermore, since the right fork 81 captures the right shift pins 75 in the right pin seats 32, this prevents accidental shifting of the switch machine, which could be caused, for example, by vibrations.

Shifting of the mechanism back to the right is accomplished in a similar fashion to the leftward shifting.

Electrical sensors incorporated in locations in the mechanism such as the forks 81, 83 act to monitor the correct or incorrect positioning of the mechanism at the right and left end points of its stroke. That is, as can readily be seen from Figure 2, an electrical sensor in the left fork 83 senses attainment of its rightmost position relative to the left operating rod 4, at the right end point of the stroke of the switch machine. Similarly, an electrical sensor in the right fork 81 senses attainment of its leftmost position relative to the right operating rod 5, at the left end point of the stroke of the switch machine. These sensors may be any suitable sensor such as shown for example in U. S. Patent No. 6,149,106 and may be engageable with the forks 81, 83 and the operating rods 4, 5. Alternatively, the sensors may be mounted elsewhere within the switch machine so as to sense the position of one element relative to another element within the switch machine.

In a first type of irregular functioning of the switch machine, an obstacle between the left switch point A1 and the left stock rail C1 can prevent the full displacement of the switch point A1 to abut the left stock rail C1. The obstacle causes the switch point A1 to stop advancing, and the displacement of the control rod 8 can not reach the predetermined end-stroke point. A sensor in the right fork 81 will

readily indicate that the control rod 8 has not reached the end of its stroke relative to the operating rods 4, 5, so that this type of irregular condition is made evident. This irregular functioning may then be communicated to associated wayside signalling equipment or remotely to a data center communicating with the switch.

A second type of irregular functioning can be caused by the absence of the stroke rail C1 in the correct position. In that case, the displacement of the switch point A1 is not opposed by the stock rail C1; therefore, the left side of the left through hole 41 never offers sufficient resistance to the movement of the left ball 42 to cause the left ball 42 to react against the sloped wall of the left ball slot 61 and move upwardly, compressing the spring 22 and entering the left ball seat 24. Therefore, the skate 6 is not released from its engagement with the left operating rod 4, and the operating rods 4, 5 continue to move to the left with the control rod 8. As in the previous example, a sensor in the right fork 81, for example, will readily indicate that the control rod 8 has not reached the end of its stroke relative to the operating rods 4, 5, so that this type of irregular condition is made evident. Such event is then communicated to other wayside equipment or a remote data center.

Figures 6 through 12 illustrate connectors, according to the present invention, for the switch machine. Figure 6 shows a side elevation view of a switch machine incorporating this modification, with the switch machine housing 1 itself being shown in section, to show the location of a bearing 102 and a seal 104 on each operating rod 4, 5. The bearing 102 aligns the operating rod 4, 5 to move along a line of action on the axis of the internal mechanism of the switch machine, while the seal 104 seals out water and other contaminants which could cause deterioration or even malfunctioning of the switch machine. A socket 106 is provided at the outer end of each operating rod 4, 5. Each operating rod socket 106 is pivotably connected to its associated switch point A1, A2, by a yoke 112, a pivot pin 108, and a mounting clip 110.

Assume that each switch point A1, A2, along with the respective section of rail to which it is attached pivots around an axis, such as the axis 200 shown in Figure 7A when the switch point is moved. However, it should be noted that the pivot radius of the rail is relatively large compared to the dimensions of the other elements shown in Figure 6, and thus the location of the axis 200 is not shown to scale. As shown in Figures 7A and 7B, as the operating rod 4, 5 moves longitudinally to move its

associated switch point A1, A2 laterally, it can be seen that the angle 140, will change slightly. That is, for example, if the operating rod 5 moves to the right, the angle 140 between the operating rod 5 and the switch point A2 will increase slightly. If the operating rod 5 were locked at a given angle relative to the switch point A2, the lateral reactive force imposed on the operating rod 5 by the pivoting switch point A2 would cause the operating rod to try to pivot in a counter-clockwise direction, as viewed in Figure 7B. Similarly, if the operating rod 5 were fixedly attached at a given point on the pin 108, pivoting of the switch point would pull the operating rod 5 to one side. These types of lateral or pivoting force on the operating rod 5 would cause it to bind in the bearing 102 and the seal 104. This binding would, at the very least, cause accelerated wear and premature failure of the bearing 102 and the seal 104. Further, this binding could actually lock up the entire switch machine, especially in the case where the two switch points are tied together as discussed hereinabove. However, the connectors, as described below, are also operative with and provide benefit for other between-the-rail switch machines, in which the switch points are not tied together, other than via the operating rods.

To prevent this binding, the socket 106, the yoke 112, and the pivot pin 108 have features which allow the switch point A2 to pivot freely relative to the operating rod 5, without imposing a reactive pivoting force on the operating rod 5. The same arrangement is provided at the connection between the operating rod 4 and its associated switch point A1. As seen better in Figure 8, the operating rod socket 106 has a vertical bore 118 therethrough, with the bore 118 being centered on a vertical axis 120. A clevis pin hole 124 can be provided laterally through the socket 106, and transversely through the socket bore 118, for use with some embodiments, as discussed below.

The yoke 112 has a vertical shaft 116, which is positionable in the socket bore 118, centered on the vertical axis 120. If not pinned to the socket 106, the yoke 112 can pivot about the vertical axis 120 of the vertical shaft 116, relative to the vertical bore 118 of the socket 106. The pivot pin 108 is rigidly mounted to the switch point by means of the mounting clip 110, with the longitudinal axis 122 of the pivot pin 108 being oriented horizontally and substantially parallel to the axis of the switch point. The yoke 112 is slidingly attached to the pivot pin 108, by means of a collar 114 at

the top of the vertical shaft 116 of the yoke 112. That is, the collar 114 at the top of the yoke 112 has a horizontal bore into which the pivot pin 108 is received, and the collar 114 is free to slide along the pivot pin 108.

As seen in Figure 9, the yoke 112 has a vertical shaft 116, at the top of which is mounted a pivoting collar 114. The collar 114 pivots about the vertical axis 120, relative to the vertical shaft 116 via a vertical pivot pin (not shown), or alternatively, it could be fixedly mounted to the vertical shaft 116, in which case the collar 114 pivots with the shaft 116. In all cases, a horizontal bore 126 is provided through the collar 114, with the collar bore 126 being centered on the horizontal axis 122 of the pivot pin 108. It can be seen that, as the collar 114 pivots, the horizontal axis 122 of the collar bore 126 pivots about the vertical axis 120 of the vertical shaft 116.

In a further embodiment, seen in Figure 10, the yoke 112 has a vertical shaft 116 and a collar 114, as before. However, in this embodiment, the collar 114 has an inner collar member 128 and an outer collar member 132, as shown in Figures 11 and 12. The collar bore 126 in this instance passes through the inner collar member 128.

The inner collar member 128 can be a truncated spherical member as shown, positioned in a spherical cavity 134 within the outer collar member 132. It will be seen that this allows the inner collar member 128 to pivot relative to the outer collar member 132, with the result that the horizontal axis 122 of the collar bore 126 pivots about the vertical axis 120. In fact, pivoting of the collar bore 126 relative to the outer collar member 132 can also have a vertical component as well as a horizontal component. If the plane of the switch point movement is not exactly orthogonal to the vertical axis 120, this vertical component of the pivoting of the collar bore 126 can be important to further prevent binding of the operating rods 4, 5. In this embodiment, as before, the outer collar member 132 may be fixedly attached to the vertical shaft 116, or it may be allowed to pivot relative thereto.

It should be understood that, whichever embodiment of the yoke 112 is used, the yoke 112 is adapted to allow the axis 122 of the collar bore 126 to pivot about the vertical axis 120, in a substantially horizontal plane. This can be accomplished by allowing the vertical shaft 116 to pivot in the socket bore 118, by allowing the collar 114 to pivot relative to the vertical shaft 116, by allowing an inner collar member 128 to pivot relative to an outer collar member 132, or by any combination of these three

mechanisms. Where some portion of the collar 114 is adapted to pivot relative to the vertical shaft 116, the vertical shaft 116 can be retained to the operating rod socket 118, by a retainer pin placed in the clevis pin hole 130. Where pivoting is accomplished by allowing the shaft 116 to pivot relative to the socket 106, the clevis pin hole 130 may not be used.

It can be seen, then, that as the operating rod 5 extends, for instance, to move its associated switch point A2 laterally to the right, the collar 114 slides along the horizontal axis 122 of the pivot pin 108, toward the free end of the switch point A2. Simultaneously, the collar bore 126 pivots about the vertical axis 120, relative to the operating rod socket 106. The combination of this sliding movement and this pivoting movement prevents the imposition of lateral reactive forces on the operating rods tending to bend or pivot the operating rod 5 relative to the bearing 102 and the seal 104.

While the particular invention as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages hereinbefore stated, it is to be understood that this disclosure is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended other than as described in the appended claims.